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Yr Is-adran Gwyddoniaeth, Ymchwil a Thystiolaeth
Science, Research, Evidence Division
Y Grŵp Iechyd, Gofal ac Atal
Health, Care and Prevention Group

Retrospective analysis of short-term projections (Winter 2025/26)

21 September 2026

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Summary

Our modelling of acute respiratory infections, including influenza, Respiratory Syncytial virus (RSV), and COVID-19 informs NHS resource planning over winter, which is a period of significant demand for the NHS in Wales. We developed a statistical model to estimate admissions up to 14 days in advance.

Following the winter of 2025/26, we assessed the model's performance by comparing its projections with the actual data. The models were implemented in a timely manner during the 2025/26 winter season and produced projections for influenza, RSV, and COVID-19 to support operational planning. Performance was particularly strong for COVID-19, where interval scores were lower and bias was minimal.

However, all models showed reduced performance during periods of rapid epidemiological change and underestimated admissions. The optimal number of basis functions was selected using the weighted interval score which may have contributed to overly narrow prediction intervals. Future methodological improvements could consider optimising interval coverage and weighted interval score jointly. Ensemble modelling could also be explored by combining alternative statistical models with additional data sources such as GP consultations. However, this would require additional time and resources and could reduce the timeliness of model delivery.

A key strength of the GAM model is its flexibility, allowing it to capture complex, non-linear trends. Overall, retrospective evaluation of short-term projections indicates that the model is able to capture broad temporal trends and estimate hospital admissions, both national and Local Health Board levels, with reasonable accuracy.

Introduction

The Science, Research and Evidence (SRE) division publishes an annual report estimating the expected pressures for the upcoming winter period. As winter season progresses, a semi-mechanistic statistical model is deployed to generate short term projections (STPs) of hospital admissions in Wales to support more accurate operational planning. These projections provide more responsive estimates during periods of changing respiratory disease activity.

The short-term projection model incorporates both spatial and temporal structures to generate two-week ahead projections of daily hospital admissions in Wales. Separate models were developed for COVID-19, influenza, and respiratory syncytial virus (RSV).

The aim of the paper is to retrospectively evaluate the performance of these short-term projections during the 2025/26 winter season by comparing projected admissions with observed admissions data across Wales.

Methods

Data Sources

- **Admissions Data:** Weekly new admissions due to COVID-19, influenza and RSV were obtained from the Public Health Wales (PHW) ICNET data. This includes all patients admitted to hospital with a positive lab test for COVID-19, influenza, and RSV either 28 days prior to hospital admission or any time after admission before the patient is discharged.
- **Population Data:** The 2024-midyear estimates for the Welsh population was obtained from the Office for National Statistics. [1]

[1] **Population estimates for the UK, England, Wales, Scotland and Northern Ireland - Office for National Statistics**

- **Geographic Information:** The geographic boundaries of health boards were retrieved from the Open Geography Portal.[2]

Model

The methods for the generalised additive model (GAMs) have been previously described [3]. The models generated daily projections of incident hospital admissions up to 14 days ahead for COVID-19, influenza, and RSV at both national and Local Health Board (LHB) levels. All methods remain the same as those described in the previous report, except for the spline tuning process, where the optimal number of basic functions was determined by minimising the weighted interval score (instead of SMAPE).

Evaluation Measures

The following scoring metrics were used to evaluate the model performance [4]:

1. **The Weighted interval score (WIS):** It is a proper scoring rule for quantile-based forecasts that jointly evaluates sharpness (uncertainty) components and penalties for over- and underprediction. Lower values indicate better forecast performance. It is applicable to all quantile forecasts and takes the entire predictive distribution into account.

2. **50% Interval coverage:** the proportion of actual data points that lie within 50% prediction interval of the model estimate, bounded between 0% and 100% (interval coverage is considered optimal when the observed coverage matches the nominal coverage i.e. 50%).

[2] **Open Geography Portal**

[3] **Retrospective analysis of short term projections**

[4] **Metric details**

3. **90% Interval coverage:** the proportion of actual data points that lie within 90% prediction interval of the model estimate, bounded between 0% and 100%.

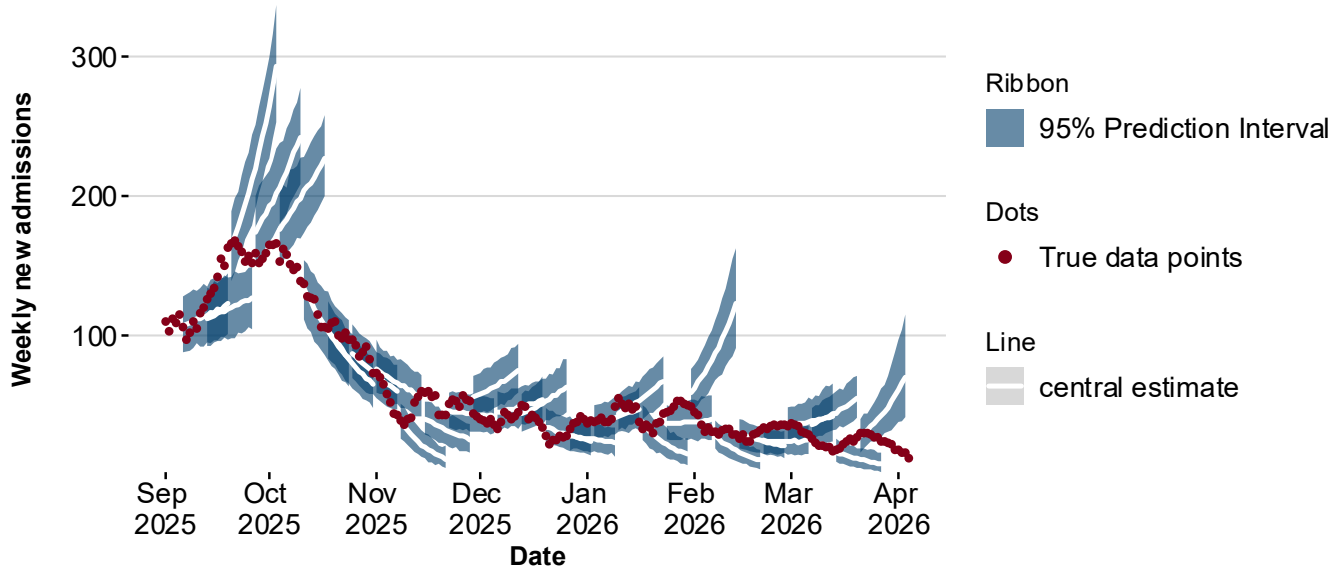
4. **Bias:** It measures the tendency of the model to over- or under-predict admissions. Bias values range from -1 to 1, where values close to zero indicate minimal systematic bias.

5. **Mean Directional Accuracy:** It represents the proportion of model estimates that correctly predicted the observed direction of change in admissions (increase or decrease).

Results

COVID-19

Figure 11: COVID-19 Admissions Projections between September 2025 and March 2026, Wales



Source: Public Health Wales and SRE Calculations

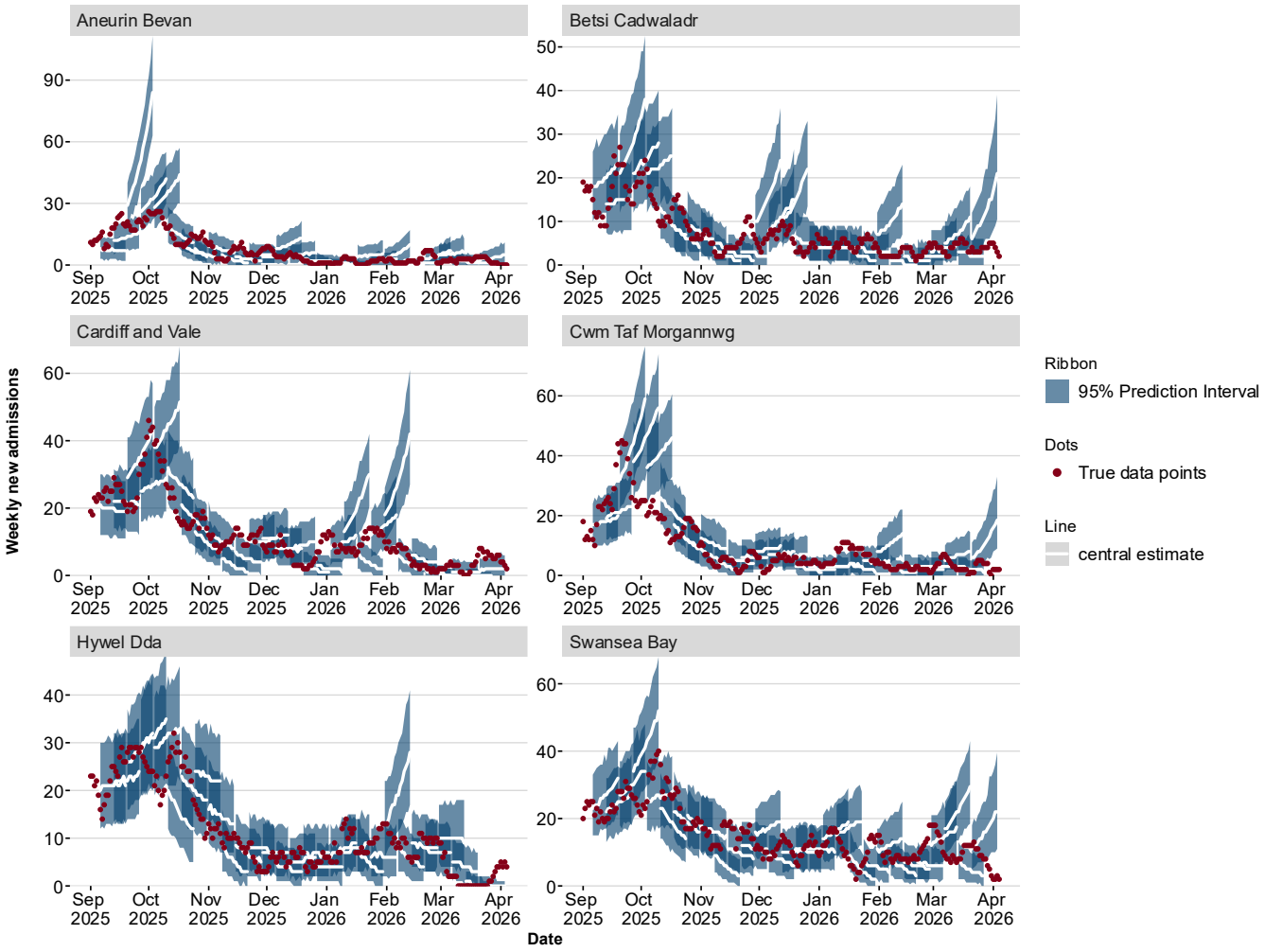
During the winter of 2025/26[5], COVID-19 hospital admissions peaked on 21 September and have declined steadily since then. Short-term COVID-19 projections were generated weekly from 6 September 2025 to 21 March 2026, covering a total of 29 projection dates (**Figure 1**11). Forecast performance varied over time, with the poorest performance observed around the peak in admissions in late September and early October 2025. Weighted interval scores (WIS) were highest during this period and decreased thereafter, remaining relatively low and stable for most of the winter, aside from a brief increase in February 2026.

Both 50% and 90% interval coverage were below the nominal coverage, indicating that prediction intervals were narrow and that forecast uncertainty was underestimated. However, bias values remained close to zero throughout the projection period, suggesting minimal systematic overprediction or underprediction.

Mean directional accuracy was low, improving after the peak and remaining relatively stable towards the end of the projection period.

[5] This is defined as the period from 1 September 2025 to 31 March 2026

Figure 22: Local Health Board COVID-19 Admissions Projections between September 2025 and March 2026, Wales

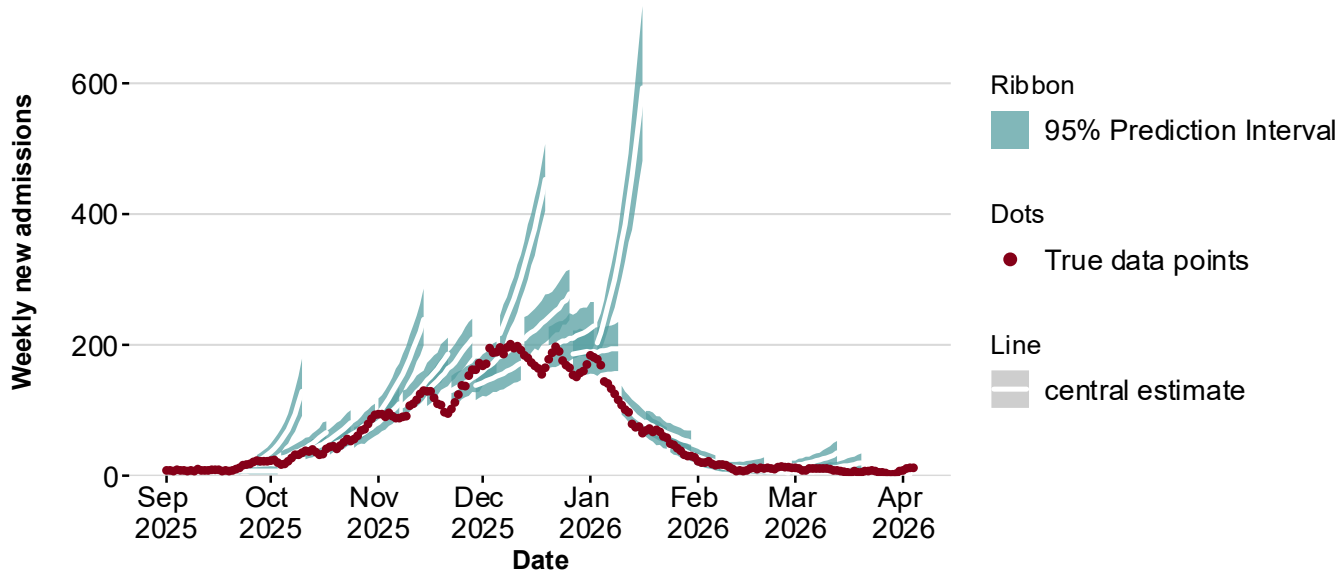


Source: Public Health Wales and SRE Calculations

Projection performance at the Local Health Board level broadly reflected the national patterns observed for COVID-19 admissions (**Figure 2**). Projection uncertainty and variability were generally greater at the LHB level, particularly in areas with lower admission counts, where relatively small changes in observed admissions produced larger proportional forecasting errors. Despite this increased variability, most LHBs showed improved forecast stability following the national peak in September 2025, with lower weighted interval scores and reduced bias during the latter part of the winter season.

Influenza

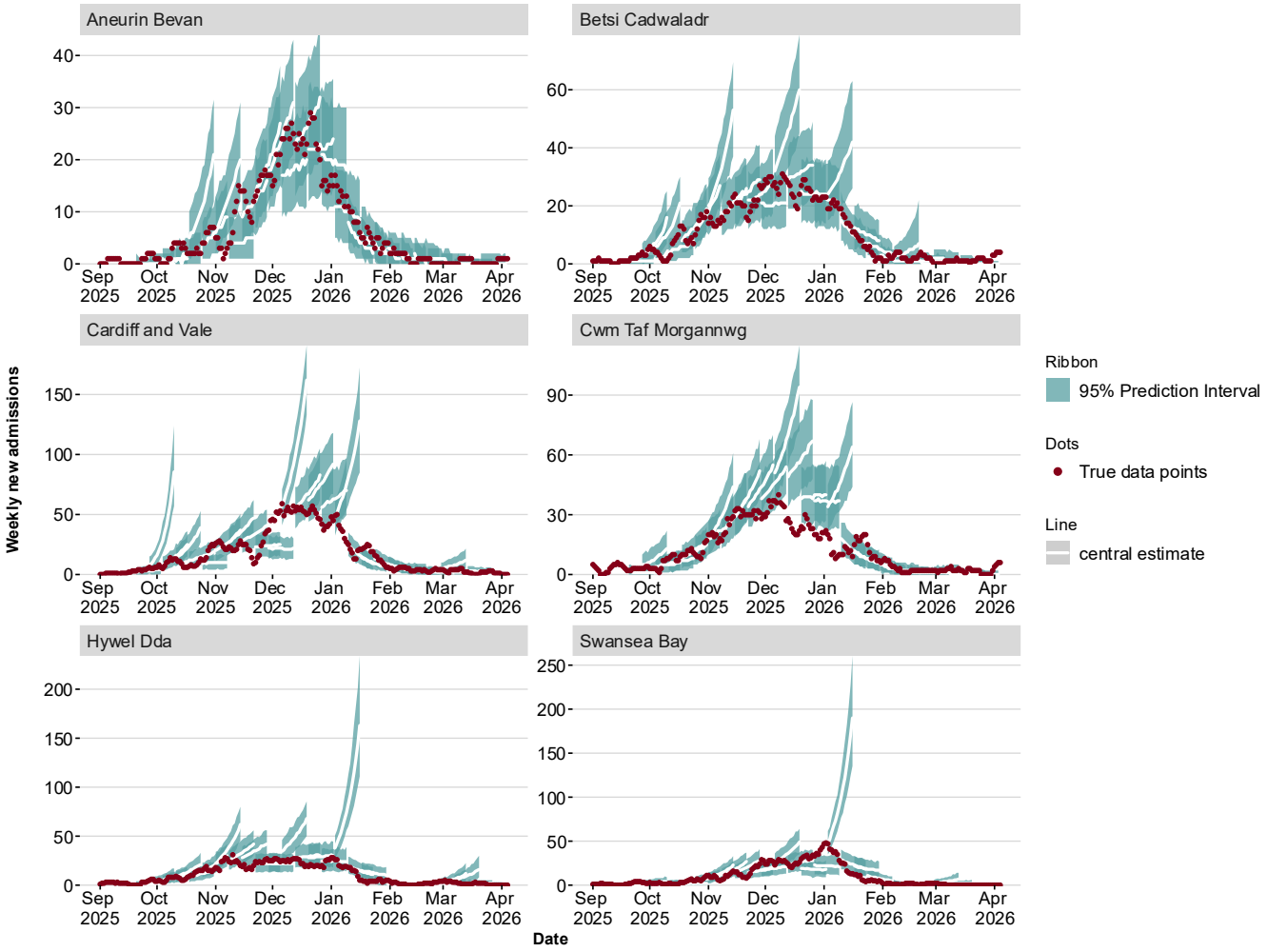
Figure 33: Influenza Admissions Projections between September 2025 and March 2026, Wales



Source: Public Health Wales and SRE Calculations

Short-term Influenza projections were produced weekly from 20 September 2025 to 21 March 2026, covering a total of 27 projection dates (**Figure 3**33). Weighted interval scores are generally low and stable through October and November 2025 but increased significantly around early December, corresponding with the seasonal peak in influenza admissions. A further pronounced increase in WIS was observed in early January 2026, indicating reduced forecast accuracy during periods of rapidly changing transmission dynamics. Both 50% and 90% interval coverage were consistently below nominal levels, suggesting that uncertainty was underestimated. Bias fluctuated significantly over the winter period, but there was an overall tendency towards over-prediction. Mean Directional accuracy was low to moderate before December 2025, but improved during and shortly after the admission peak, indicating improved ability to capture short-term trends during the descending phase of the epidemic.

Figure 44: Local Health Board Influenza Admissions Projections between September 2025 and March 2026, Wales



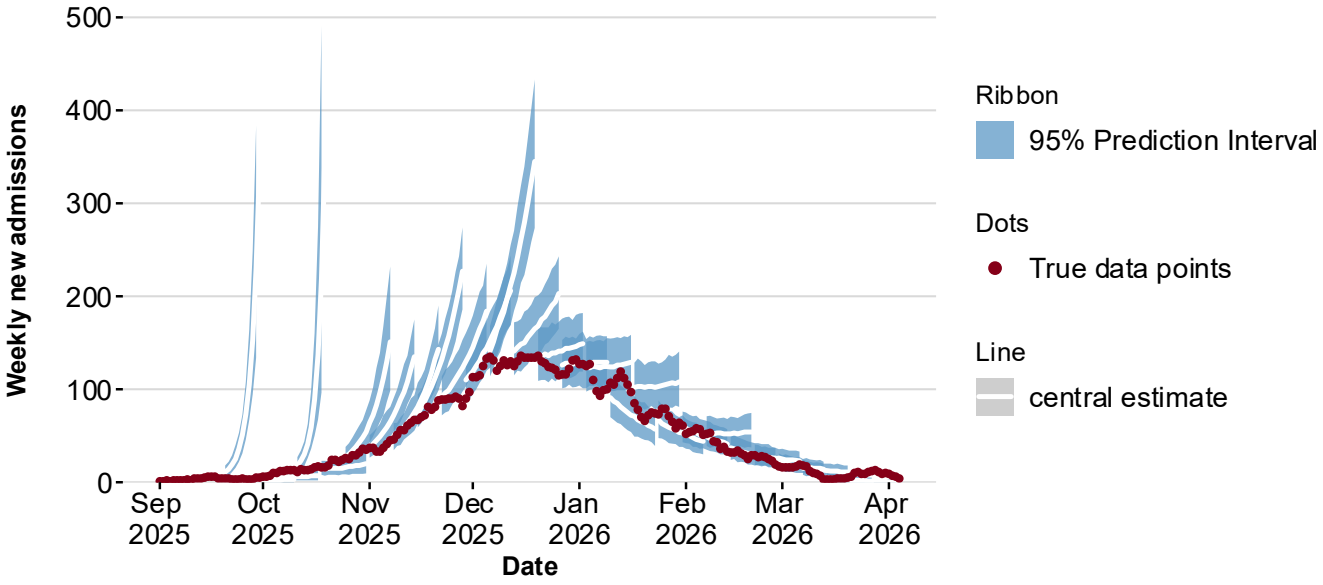
Source: Public Health Wales and SRE Calculations

Local Health Board influenza projections generally mirrored national trends, with a notable rise in weighted interval scores (WIS) occurring in early January 2026. The largest increases in WIS were seen in Hywel Dda and Swansea Bay, where the model projected a peak nearly four times higher than what was actually observed. In contrast, projections for Aneurin Bevan were notably accurate, with the model estimating the peak most closely to the observed data.

RSV

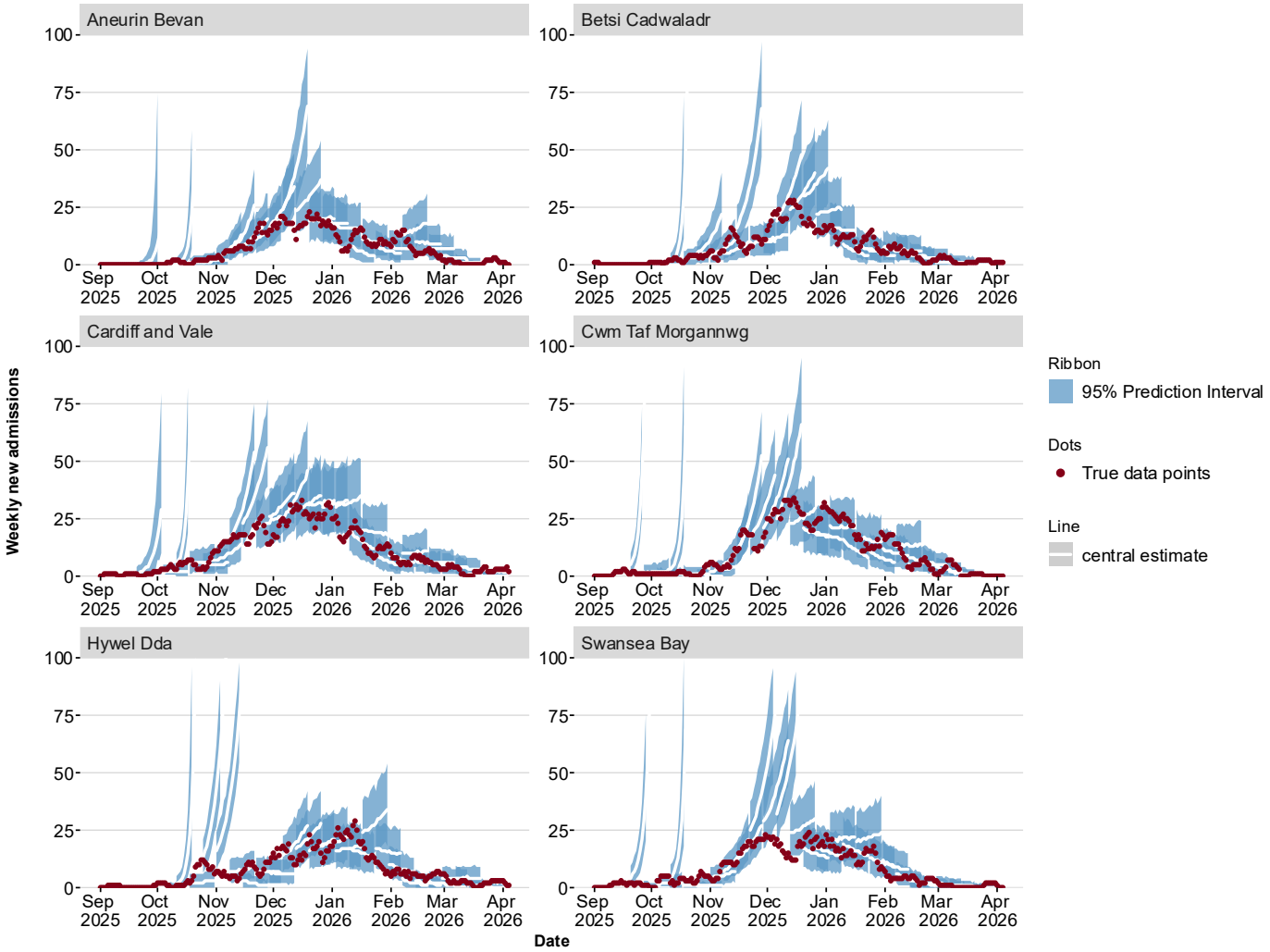
Short-term RSV projections were produced weekly from 20 September 2025 to 21 March 2026, covering a total of 27 projection dates (**Figure 5**55). WIS values were very high in early autumn, with two very large spikes observed for projections generated on 20 September 2025 and 11 October 2025, indicating that the model substantially overpredicted admissions on two occasions during the growth phase of the RSV admissions. As observed with the influenza and COVID-19 models, interval coverage was generally low but increased over the course of the winter period. Mean directional accuracy also improved through the winter while the bias values remained mainly above zero throughout.

Figure 55: RSV Admissions Projections between September 2025 and March 2026, Wales



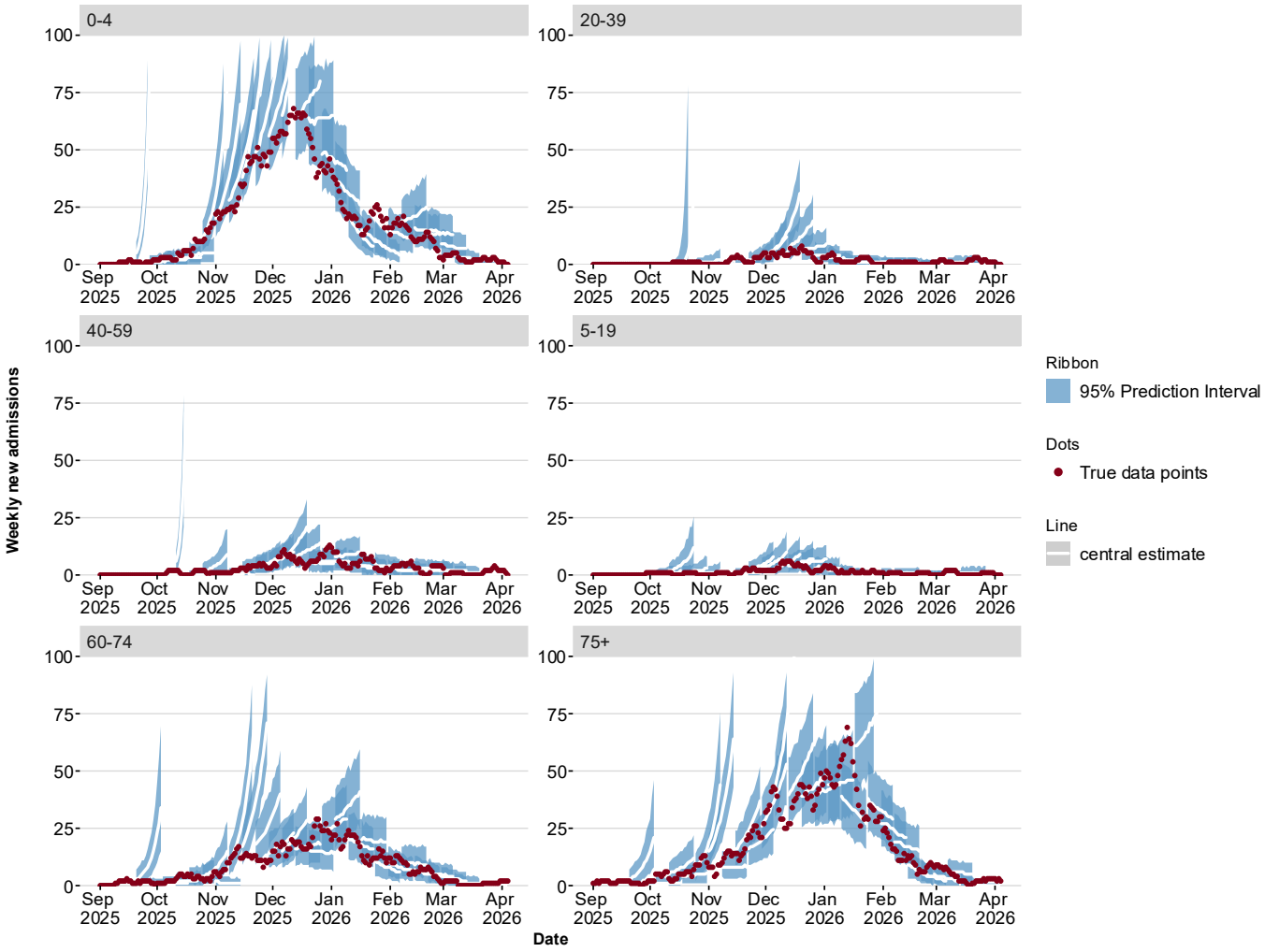
Source: Public Health Wales and SRE Calculations

Figure 66: Local Health Board RSV Admissions Projections between September 2025 and March 2026, Wales



Source: Public Health Wales and SRE Calculations

Figure 77: RSV Admissions Projections between September 2025 and March 2026 in Wales, by age group



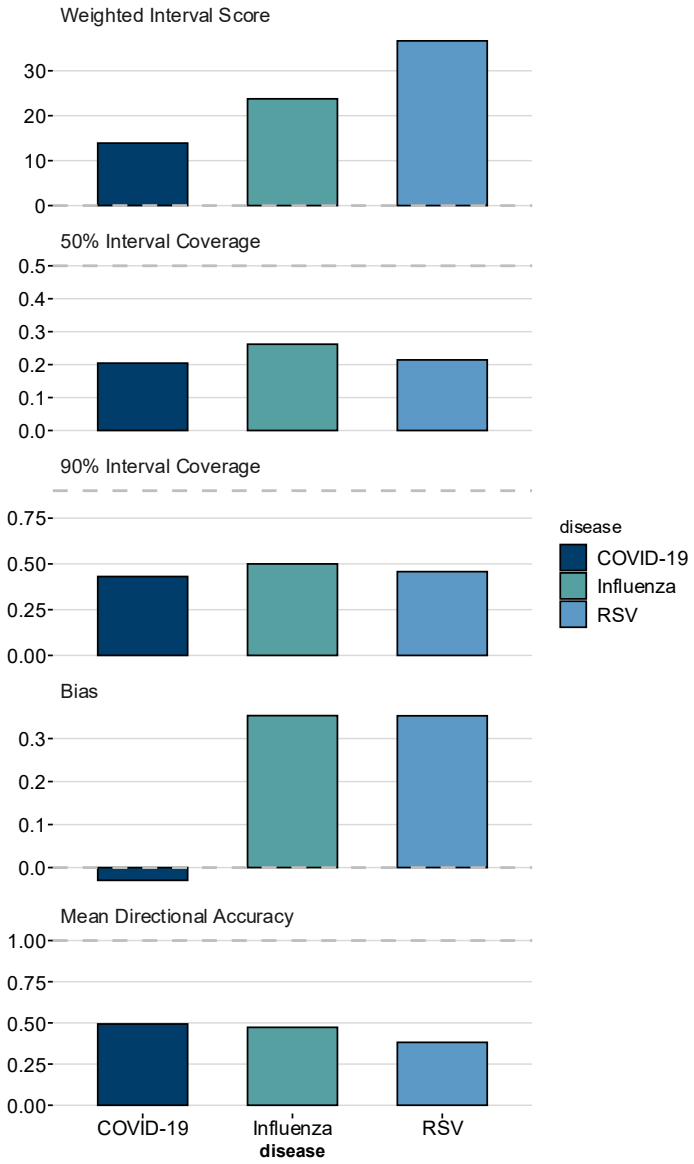
Source: Public Health Wales and SRE Calculations

Model uncertainty and performance metrics were worse at the local health board level and age group level when compared to the national level. RSV projections for age groups with higher admission counts, specifically children aged 0–4 years and adults aged 75 and older, showed better model performance compared to other age groups such as 20–39 years, 40–59 years, and 5–19 years.

Conclusion

In conclusion, we evaluated model performance using five metrics: Weighted interval score (WIS), 50% interval coverage, 90% interval coverage, bias, and mean directional accuracy. Overall, the COVID-19 model exhibited lower interval scores and less bias compared with the influenza and RSV models, indicating better performance (**Figure 8**).

Figure 88: Performance metrics of the COVID-19, Influenza, and RSV GAM model throughout the 2025/26 winter season



All three models showed interval coverage scores that were on average lower than nominal levels, however, the influenza and RSV models showed higher coverage than the COVID-19 model. Mean directional accuracy was higher for the COVID-19 and influenza models, suggesting better ability to capture directionality of short-term trends.

Table 1: Overall performance metrics of the COVID-19, Influenza and RSV GAM model at the national level throughout the 2025/26 winter season

Disease	Weighted Interval Score	50% Interval Coverage	90% Interval Coverage	Bias	Mean Directional Accuracy
COVID-19	13.90	0.20	0.43	-0.03	0.49
Influenza	23.76	0.26	0.50	0.35	0.47
RSV	36.66	0.21	0.46	0.35	0.38

Source: Public Health Wales and SRE Calculations

Performance across all models was poorest during epidemic growth phases and around seasonal peaks, where admission trends changed rapidly. This pattern suggests that the models were better suited to capturing stable or declining trends than abrupt increases in hospital admissions. Additionally, projections at the local health board level that involved low numbers of admissions showed the weakest performance possibly due to increased variability and noise in the data.

The optimal number of basis functions was selected using the weighted interval score, which combines forecast sharpness and penalties for under- and over-prediction. This approach may have contributed to overly narrow prediction intervals. Future methodological improvements could consider optimising interval coverage and weighted interval score jointly, for example using a Pareto front framework.[6] Ensemble modelling could also be explored by combining alternative statistical models with additional data

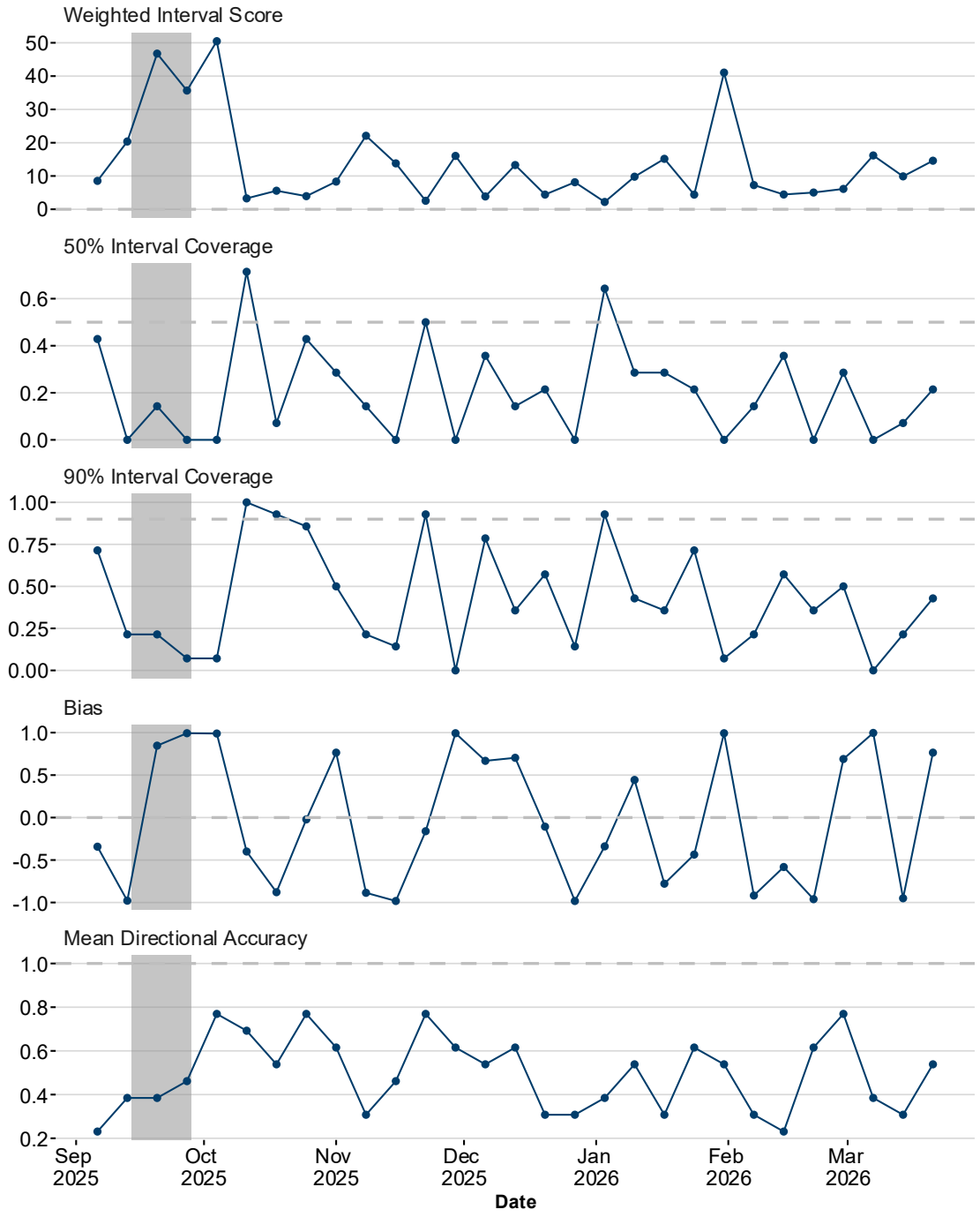
sources, such as GP consultations. However, this would require additional time and resources and could reduce the timeliness of model delivery.

Overall, retrospective evaluation of short-term projections indicates that the model is able to estimate hospital admissions with reasonable accuracy. A key strength of the GAM model is its flexibility, allowing it to capture complex, non-linear trends. The models were implemented in a timely manner during the 2025/26 winter season and produced projections for influenza, RSV, and COVID-19 to support operational planning. They successfully captured broad temporal patterns in hospital admissions at both national and Local Health Board levels. Performance was particularly strong for COVID-19, where interval scores were lower and bias was minimal. However, all models showed reduced performance during periods of rapid epidemiological change where sudden shifts in underlying transmission dynamics were more difficult to capture and consistently underestimated forecast uncertainty.

The projections were communicated to users throughout the winter and were published in weekly **communicable disease reports**. Feedback from users indicated that the models were summarised clearly and providing estimates of all admissions with regards to RSV, flu and COVID-19 were particularly valuable for supporting decision-making.

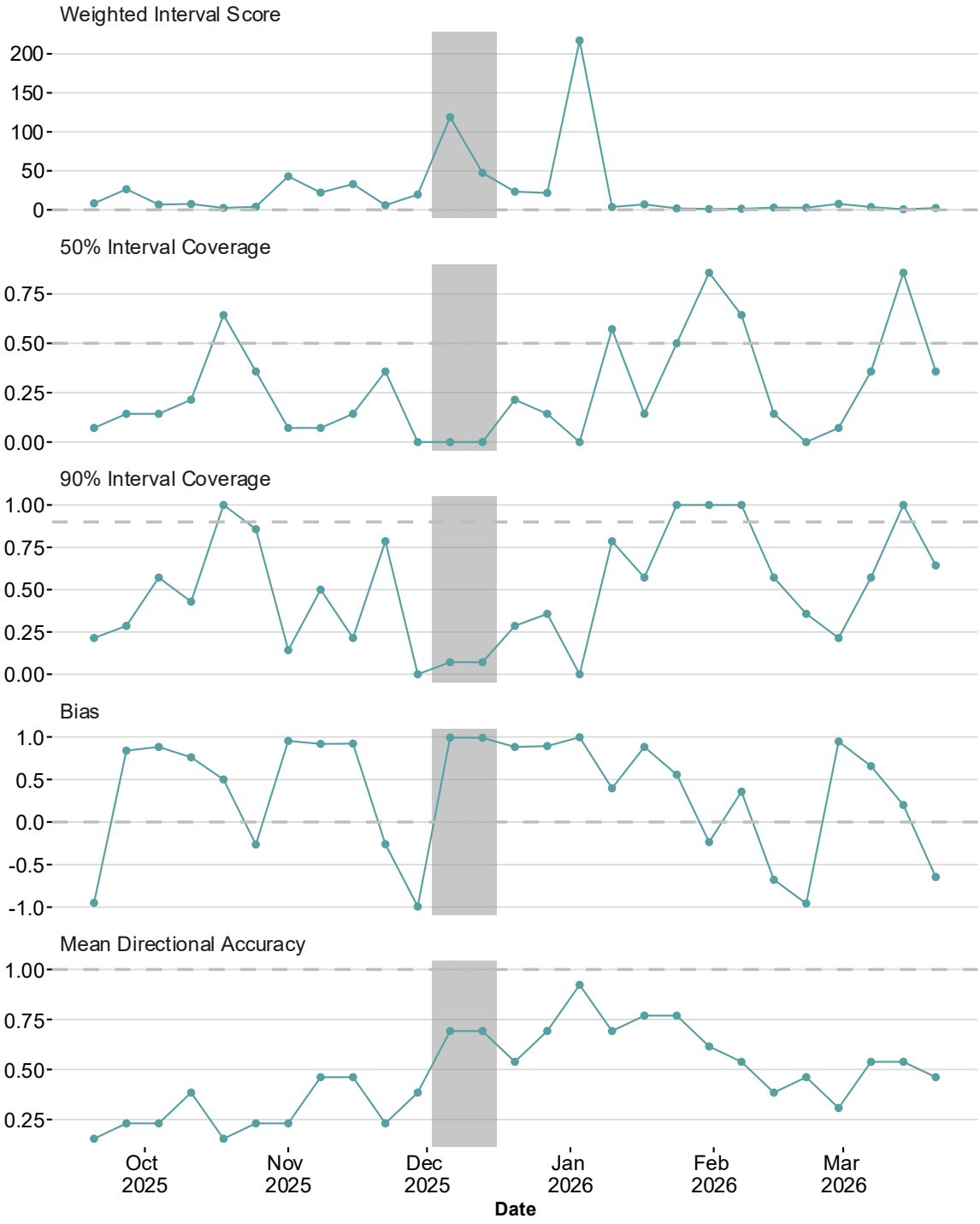
Annex

Figure S19: Performance metrics of COVID-19 model at the national level by projection date [Note 1]



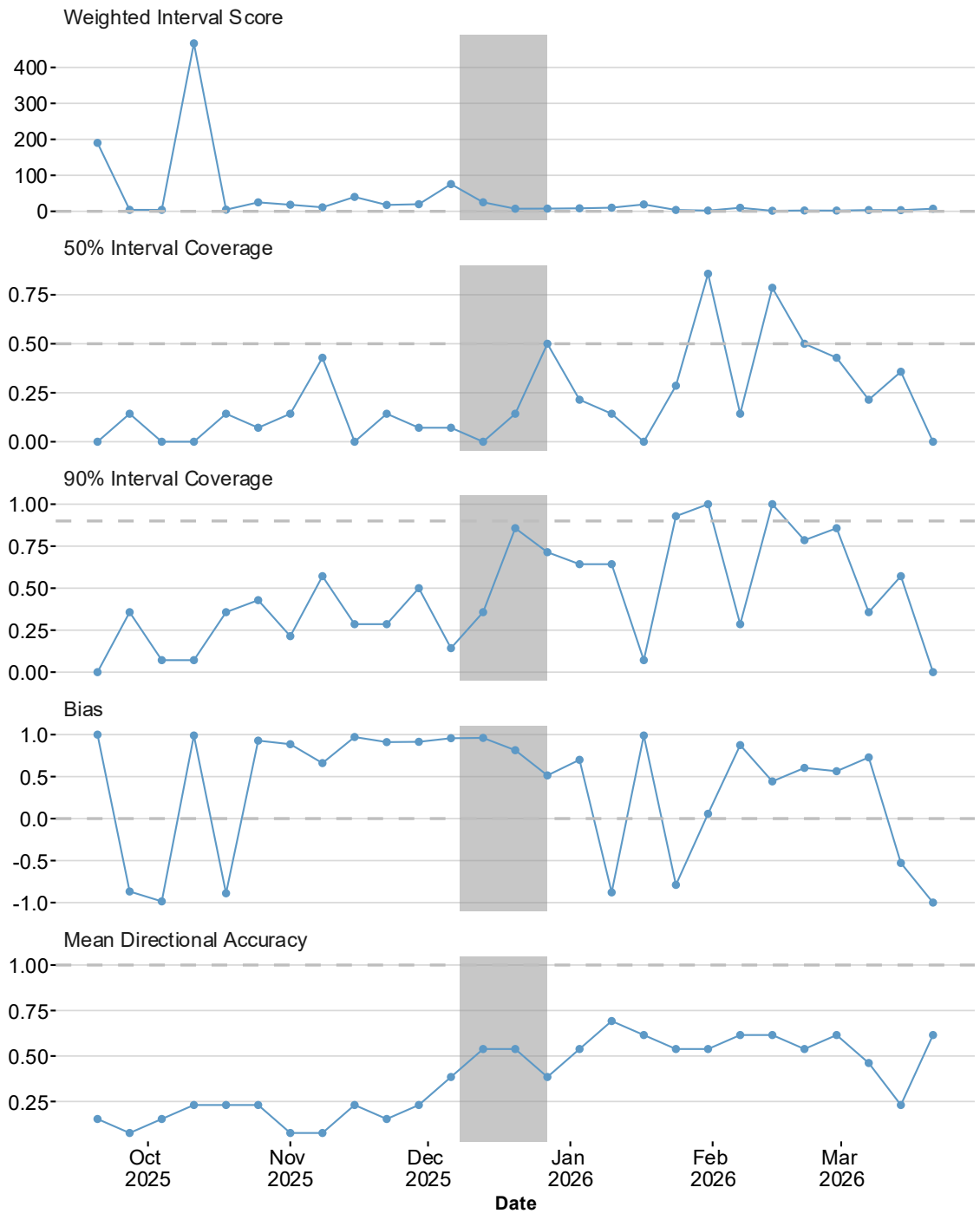
Source: Public Health Wales and SRE Calculations

Figure S210: Performance metrics of influenza model at the national level by projection date. [Note 1]



Source: Public Health Wales and SRE Calculations

Figure S311: Performance metrics of RSV model at the national level by projection date [Note 1]



Source: Public Health Wales and SRE Calculations